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TITLE: FRAME SYSTEM FOR MEMBRANE FILTRATION MODULES**TECHNICAL FIELD**

The present invention relates to membrane filtration systems employing banks of membrane modules and, more particularly, to support or mounting
5 frames and methods for such modules.

BACKGROUND OF THE INVENTION

Modular filtration systems employing arrays of membrane modules connected by common fluid flow manifolds are used to allow systems of varying capacity to be constructed according to the needs of a particular customer.
10 These systems are typically constructed by building the module array and then an independent external frame or "exoskeleton" is built around the module array either in the factory or onsite to support the modules and provide a robust structure. Typically, the frames and module arrays are manufactured and transported separately due to size constraints and the assembled on site. This
15 involves a lot of expensive "double handling" the various components of the eventual operating system.

Such support structures require costly design and manufacture as well as different designs each time the size of the module array is varied. There is a need for a simpler support system which can easily accommodate varying
20 system size requirements while reducing structure size and cost. A compact structure enables shipping of the complete system as a single unit from the manufacturing factory to the user's site.

DISCLOSURE OF THE INVENTION

The present invention seeks to overcome or at least ameliorate one or
25 more of the above disadvantages of the prior art or provide a useful alternative.

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According to one aspect, the present invention provides a filtration system comprising a plurality of membrane modules arranged in an array and the membrane module array being divided into membrane module array sub-groups by a spacing between numbers of modules within the membrane module array and an integrated support member located within said spacing to support said
5 membrane module array.

According to another aspect of the invention there is provided a method for providing structural support to an array of membrane filtration modules in a filtration system comprising the steps of:

10 forming a number of sub-groups of modules within the array of filtration modules by providing a spacing between a number of modules forming a sub-group;

locating a structural support member within the spacing between adjacent sub-groups.

15 Preferably, the membrane modules extend between first and second fluid communicating manifolds and the support member is connected to at least one of said manifolds to support said membrane module array. For preference, the manifolds comprise upper and lower manifolds and the membrane modules extend generally vertically therebetween. Preferably, a number of support
20 members may be connected together to form a support structure.

The membrane modules may comprise bundles of hollow fibre membranes extending between spaced headers. The filtration system may be a pressurised or non-pressurised submersed membrane filtration system.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 shows a left side isometric view of a module arrangement
5 according to a first embodiment of the invention;

Figure 2 shows a right side isometric view of a module arrangement
according to embodiment of Figure 1;

Figure 3 shows a left side elevation view of a module arrangement
according to embodiment of Figure 1;

10 Figure 4 shows an end elevation view of a module arrangement according
to embodiment of Figure 1;

Figure 5 shows a right side elevation view of a module arrangement
according to embodiment of Figure 1;

Figure 6a shows an elevation view of the frame employed in the
15 embodiment of Figure 1;

Figure 6b shows a left side elevation view of the frame employed in the
embodiment of Figure 1;

Figure 6c shows a right side elevation view of the frame employed in the
embodiment of Figure 1;

20 Figure 6d shows a plan view of the frame employed in the embodiment of
Figure 1;

Figure 7 shows a left side isometric view of a module arrangement
according to a second embodiment of the invention;

Figure 8 shows a left side elevation view of a module arrangement
25 according to embodiment of Figure 7;

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Figure 9 shows a plan view of a module arrangement according to embodiment of Figure 7;

Figure 10 shows an end elevation view of a module arrangement according to embodiment of Figure 7;

5 Figure 11 shows an isometric view of the frame employed in the module arrangement according to the embodiment of Figure 7;

Figure 12 shows an isometric view of a module arrangement according to a third embodiment of the invention;

Figure 13 shows an isometric view of a module arrangement according to a
10 fourth embodiment of the invention;

Figure 14 shows an isometric view of a module arrangement according to a fifth embodiment of the invention;

Figure 15 shows an isometric view of a module arrangement according to a sixth embodiment of the invention;

15 Figure 16 shows a left side end elevation view of the module arrangement of the embodiment of Figure 15;

Figure 17 shows a right side end elevation view of the module arrangement of the embodiment of Figure 15;

Figure 18 shows an isometric view of a module arrangement according to a
20 seventh embodiment of the invention; and

Figure 19 shows a right side elevation view of a module arrangement according to embodiment of Figure 18.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to Figures 1 to 7, a module arrangement according to a first
25 embodiment of the invention is shown.

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The module arrangement 5 consists of a plurality of membrane modules 6 arranged in a two dimensional array 7 and extending between upper and lower block-type manifolds 8 and 9, respectively. The array of modules is further divided into sub-groups of modules 10 separated from each other by space 11 extending transversely across the membrane array 7. An integrated support frame 12 is positioned in the space 11 between the sub-groups 10 and is fixed to the upper and lower manifold blocks 8 and 9 to form an integrated support structure within the module array 7.

The support frame 12 is shown in more detail in Figures 6a to 6d. The support frame 12, according to this embodiment, is generally inverted U-shape in configuration having an upper cross portion 13 and a pair of downwardly extending arms 14 and 15 respectively. Associated flanges 16 and 17 are provided at the end of each arm 14 and 15 for connection to the lower manifold block 9. A laterally extending cross member 18 is provided adjacent the upper cross portion 13 for connection to the upper manifold block 8 and hangs therefrom.

Referring to Figures 8 to 11, a module arrangement according to a second embodiment of the invention is shown. This embodiment is generally similar to the first embodiment described above with some minor changes.

In this embodiment, the upper and lower manifold blocks 8 and 9 are provided with further upper manifold pipes 19 and 20 extending along opposite sides of the upper manifold blocks 8 and further lower manifold pipes 21 and 22 extending along opposite sides of the lower manifold blocks 9.

The frame used in this embodiment is best shown in Figure 11. The support frame 12, according to this embodiment, is generally rectangular-

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shaped in configuration having a base portion 23 and a pair of upwardly extending arms 14 and 15 respectively, extending to an upper cross portion 13. The upper cross portion 13 has a pair of cross members 24 and 25 provided at each end 26 and 27 and extending at right angles with respect to the rectangular
5 body of the support frame 12. Respective strengthening gussets 28, 29, 30 and 31 are provided between the cross portion 13 and the cross members 24 and 25.

As best shown in Figure 9, the support frame 12 sits within the space 11 between the sub-groups 10 and hangs from the upper manifold blocks by means
10 of the cross members 24 and 25 which extend longitudinally along the upper manifold blocks 8 generally parallel to the upper manifold pipes 19 and 20.

Figures 12 to 13 show three different embodiments of the invention employing different support structures for the support frame.

Referring to the embodiment shown in Figure 12, the frame 12 in this
15 embodiment is generally "hatch" shaped in configuration with each portion of the frame 12 extending beyond the portion to which it joins. As shown, the extended portions 32 and 33 of the upper cross portion 13 support the upper manifold pipes 19 and 20. The extended portions 34 and 35 of the base portion 23 sit above the lower manifold pipes 21 and 22 and may be attached thereto by
20 suitable fittings.

Referring to the embodiment shown in Figure 13, the frame 12 in this embodiment is generally rectangular-shaped in configuration with only the base portion 23 and the upper cross portion 13 of the frame 12 extending beyond the portion to which it joins. As shown, the extended portions 32 and 33 of the
25 upper cross portion 13 are connected to a respective spool piece 36 and 37

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located in the upper manifold pipes 19 and 20 adjacent the space 11. The extended portions 34 and 35 of the base portion 23 are also connected to a respective spool piece 38 and 39 located in the lower manifold pipes 21 and 22 adjacent the space 11.

5 Referring to the embodiment shown in Figure 14, the frame 12 in this embodiment is generally rectangular-shaped in configuration with an open base portion and the upper cross portion 13 of the frame 12 extending beyond the portion to which it joins. As shown, the extended portions 32 and 33 of the upper cross portion 13 are connected to the upper manifold pipes 19 and 20
10 adjacent the space 11. The lower portion of the frame is provided with longitudinally extending rails 41 and 42 which extend parallel to and inwards of the lower manifold pipes 21 and 22. The rails 41 and 42 may join with other frames along the length of the module array 5 to form a skid on which the module array 5 is supported.

15 Figures 15 to 17 show a further embodiment of the invention where the unused block manifolds located at end of the space 11 between the module sub-groups are employed to provide further fluid flow capacity to the module array 5. As best shown in Figure 15, the unused manifold blocks 43, 44 and 45 may be rotated through 90 degrees or provided with a T-piece to allow connection of
20 further piping 46, 47, 48 and 49, which extends parallel with the moulded block manifolds and provides for additional fluid flow paths from the upper and lower manifolds of the module array 5. These additional fluid flow paths may be used to provide additional feed, filtrate and waste drain flows to the module array through piping 46, 47 and 48/49, respectively.

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Figures 18 and 19 show a further a further embodiment of the invention where the support frames 12 are joined to longitudinally extending support rails 50 and 51. Again the support frame 12 is generally "hatch" shaped in configuration with each upper portion of the frame 12 extending beyond the portion to which it joins. As shown, the extended portions 32 and 33 of the upper cross portion 13 support the respective longitudinally support rails 51 and 52. The base of each of the vertical arms 14 and 15 of each support frame 12 are provided with support feet or flanges 52 and 53 for fixing the module arrangement to a support base when installed. The support rails 51 and 52 sit beneath the outer upper manifold blocks 8 to support the membrane module array 7. The support frames 12 are positioned at each end of the array 7 and within the space 11 between module sub-groups 10. The support rails 51 and 52 are in the form of I-shaped beams and the upper cross members 13 are C-shaped in cross-section to provide maximum strength at low weight.

It will be appreciated the use of a support system, as described above, enables the filtration system to be constructed as single unit which can be readily transported to user sites. The system can also be readily adapted to different size and capacity requirements as desired by a customer without the requirement for redesign of the support system. The use of the integrated support system enables, in some embodiments, for the overall footprint of the system to be reduced leading to reduced transport and site costs. The number of support members can be readily changed to allow for varying degrees of structural integrity, as required, for example in regions of high seismic activity.

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It will be appreciated that further embodiments and exemplifications of the invention are possible without departing from the spirit or scope of the invention described.

CLAIMS

1. A filtration system comprising:

a plurality of membrane modules arranged in a membrane module array,
wherein the membrane module array is divided into membrane module
array sub-groups by a spacing between numbers of modules within the
5 membrane module array; and

an integrated support member located within said spacing to support said
membrane module array.
2. A system according to claim 1 wherein the membrane modules extend
10 between first and second fluid communicating manifolds and the support
member is connected to at least one of said manifolds to support said
membrane module array.
3. A system according to claim 2 wherein the manifolds comprise upper and
lower manifolds and the membrane modules extend generally vertically
15 therebetween.
4. A system according to claim 2 wherein a number of the support members
are connected together to form a support structure.
5. A system according to claim 1 wherein membrane modules comprise
bundles of hollow fibre membranes extending between spaced headers.
- 20 6. A system according to claim 1 wherein the system is a pressurised
membrane filtration system.
7. A system according to claim 1 wherein the system is a non-pressurised
submersed membrane filtration system.
8. A method for providing structural support to an array of membrane
25 filtration modules in a filtration system, the method comprising the steps
of:

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forming a number of sub-groups of modules within the array of filtration modules by providing a spacing between a number of modules forming a sub-group;

5 locating a structural support member within the spacing between adjacent sub-groups.

9. A method according to claim 8 wherein the membrane modules extend between first and second fluid communicating manifolds and the support member is connected to at least one of said manifolds to support said membrane module array.
- 10 10. A method according to claim 9 wherein the manifolds comprise upper and lower manifolds and the membrane modules extend generally vertically therebetween.
11. A method according to claim 9 further comprising connecting together wherein a number of the support members thereby form a support
15 structure.
12. A method according to claim 8 wherein membrane modules comprise bundles of hollow fibre membranes extending between spaced headers.
13. A method according to claim 8 wherein the filtration system is a pressurised membrane filtration system.
- 20 14. A method according to claim 8 wherein the filtration system is a non-pressurised submersed membrane filtration system.